concepts with linking words. The relationships between concepts are called cross-links.

Computer software programs for concept mapping are better than the “paper and post-it” approach because they allow the user to readily rearrange concepts and linking statements to restructure the map. Among the many software programs that fulfill the task of constructing digital concept maps, the CmapTools software is one that is available free at <http://cmap.ihmc.us/> and was developed by the Institute for Human and Machine Cognition (IHMC). It allows the construction of concept maps within an Ausubel-Novak cognitive-constructivism framework, where individuals create knowledge by linking new concepts to prior knowledge. In fact, this software demands linking words, thus enabling the construction of propositions that form meaningful statements called semantic units. This cartography of hierarchical statements allows better communication between experts and learners.

This software is user-friendly, and enables users to create maps that can link resources to specific concepts through a simple drag-and drop operation, such as text, PowerPoint presentations, photos, videos, graphs, websites, and even other concept maps. There is a tutorial page that can help users to start their navigation in the software.

I have used this software in conjunction with a datashow in lectures as a diagnostic tool to measure learners’ previous knowledge structures. Also, it has been useful in challenging students to collaborate in the construction of a collective concept map, thus enabling the visualization of the changes during the progress of their work. Participating individuals can be in the same room or anywhere in the world since the maps can be built synchronously or asynchronously, thus allowing users to collaborate at distance. In this way they may share and publish their concept maps on the Internet, link resources, and search the World Wide Web for information related to the map. The concept maps built using CmapTools can be stored on servers, creating a digital portfolio that is a product of the learning, thus enabling evaluation of student performance. As an option in the individual construction of the map, Cmap students can also collaborate through a “knowledge soup” that enables them to share propositions without showing each other their maps, thus encouraging the participation of each and every student. Another important option I have used for assessment and feedback is the recorder feature of CmapTools. This function allows one to record and play back each of the steps of map construction, labeling and identifying each contributor, thus allowing learners to be actively engaged in the “meaning building” metacognition process. Another feature of CmapTools that I have used for formative assessment is the “compare concept maps” tool, which enables the comparison of an “expert” concept map for a specific topic (constructed by the professor or another learner) to a learner’s map, or to compare the new student version of a concept map with the previous one, making explicit the degree of integration of concepts. Overall, I recommend

The Software CmapTools—IHMC and Microbiology: a Bridge to Meaningful Learning?

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Review of: *Cmap*, an online concept mapping tool from *The Institute for Human and Machine Cognition*
<http://cmap.ihmc.us/>

A concept map is represented by a visual-spatial network of propositions that represent knowledge structure. It acts as a tool for meaningful learning by presenting information using a hierarchical tree-like branching structure illustrating the holistic relatedness of ideas. In concept mapping, one identifies the important concepts from subject matter and describes the relationship between those

this software to all microbiology students. It has been recognized by my own students' feedback as an essential tool for enhancing meaningful learning.

I also recommend, the coupling of CmapTools with the pedagogical tool "Gowin's V" (see article at <http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED200437>), for the instructor who wishes to design more challenging and investigative laboratory courses.

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